6.1 MUNICIPAL INTAKE OPTIONS

The City of Port Angeles currently uses a Ranney collector to obtain water for municipal use. The construction and capacity of the existing Ranney collector is described in Section 4.1. It is anticipated that the current Ranney collector will continue to be used to supply water for a newly constructed municipal treatment plant. Even though the existing Ranney collector does an excellent job removing suspended solids from the Elwha River as indicated in Section 2.2, it is recommended that two improvements be considered. The existing two 600 Hp pumps (3700 gpm @ 1,530 ft) may need to be adjusted to boost the water to the new treatment plant depending on the site of the plant. A second improvement is that an air scour Ranney backwash system is needed during the first 5-years after the dam's removal due to the potential that sediment released during the dam demolition may affect Ranney capacity unless the Ranney is not used during high turbidity periods.

There is some concern over the declining yield observed in the City's existing Ranney collector as described in Section 4.1.2. The decrease in yield is assumed to be the result of migration of the river channel away from the collector. Continued migration or excessive aggradation of the river bed may potentially impact collector yield. The release of sediments associated with dam removal could accelerate this migration, although it could just as easily remedy the situation by causing the river to move back towards the Ranney collector. The *EIS* (ONP, 1996) proposed the construction of a new Ranney collector on the west side of the river offset possible river migration.

The municipal treatment plant constructed for the City will be capable of treating surface water under the requirements of the SWTR. The City currently has an industrial surface water intake capable of obtaining approximately twice as much as their permitted water right. A simple interconnection between the existing surface water intake or any other industrial intake proposed in this report will easily supplement any decrease in yield from the City's existing collector. An interconnection between the surface water intake, a recommended industrial and fisheries mitigation supply alternative and the existing Ranney collector is proposed as part of the mitigation measures for the City's municipal system. If needed, the National Park Service will assist the City in the development of a Habitat Conservation Plan for operation of the City's municipal and industrial water supply facilities, including provision for relocation of river flow to the east bank of the river in the vicinity of the Ranney well. The construction of an additional collector is unnecessary with these provisions.

6.2 GENERAL TREATMENT OPTIONS

As discussed in Section 3.2, the source water for the Ranney collector well currently used by the City of Port Angeles was classified as GWI in April 2000 by WDOH. Consequently, the proposed water treatment plant should be designed to meet the requirements of the SWTR. Several options to provide the required level of additional treatment have been reviewed and evaluated in consideration of the anticipated impacts of dam removal and the recent GWI classification. These options are based on the treated water production capacity of 10.6 mgd (16.4 cfs). To account for water production losses due to residuals disposal and backwashing the process capacity for each option has been sized for a nominal value of 11 mgd. The options include:

- Conventional Treatment
- Direct Filtration
- Ultra Filtration (UF) Membranes
- High Rate Treatment
- Diatomaceous Earth Filtration
- Slow Sand Filters

All of the treatment processes described below assume the existing Ranney collector will continue to be used as the municipal water intake and act as a pre-treatment process. The water would be pumped from the Ranney collector to a separate treatment facility. All of the treatment processes presented would be followed by a disinfection process. Disinfection process options are described in Section 6.4.

A comparison of the suggested raw water quality requirements for different treatment methods is presented in Table 6.1. This table is for comparative purposes only. Actual maximum values will depend on design and operation specifics.

Table 6.1

SUGGESTED MAXIMUM LIMITS ON RAW WATER QUALITY FOR ALTERNATIVE MUNICIPAL TREATMENT PROCESSES

Water Quality Parameter	Conventional Treatment[1]	Direct Filtration[1]	UF Membranes[1]	Actiflo[2]	Super Pulsator[2]	Diatomaceous Earth[2]	Slow Sand Filters[1]
Turbidity (NTU)	1,000	20	100	4,000	5,000	20	10
Color	1,000	20	15	500	250	5	25
Alkalinity (mg/L)	500	200	150	350	150	20	INA
Hardness (mg/L)	700	150	150	600	200	300	INA
Iron (mg/L)	2	0.5	0.5	10	>1	0.3	1
Manganese (mg/L)	0.5	0.1	0.1	1	>1	0.05	1
TOC (mg/L)	7	2.5	2	40	25+	INA	INA
Taste and Odor	10	4.5	3	INA	INA	INA	INA
Algae (ASU/mL)	10,000	1,000	1,000	30,000	10,000	No Upper Limit/Reduces Cycle	INA
Giardia (100 L)	20	3	100	2×10^8	INA	INA	INA
Cryptosporidium (100 L)	10	1	100	2×10^6	INA	INA	INA
Coliform (#/mL)	1,000,000	1,000	10,000	5,000,000	INA	INA	INA

1. Source : "Integrated Design and Operation of Water Treatment Facilities", Second Edition, Susumu Kawamura, Chapter 2 - Preliminary Studies, page 40, Table 2.4.5-1 Suggested Raw Water Quality for Practical Treatment Processes.
2. Information provided by manufacturer.

INA – information not available.

Each of the treatment options was evaluated based on capital costs, O&M requirements and associated costs, treatment capabilities, specific treatment requirements based on the Ranney collector water quality data, the anticipated effects of dam removal, and land use requirements.

6.2.1 Conventional Treatment

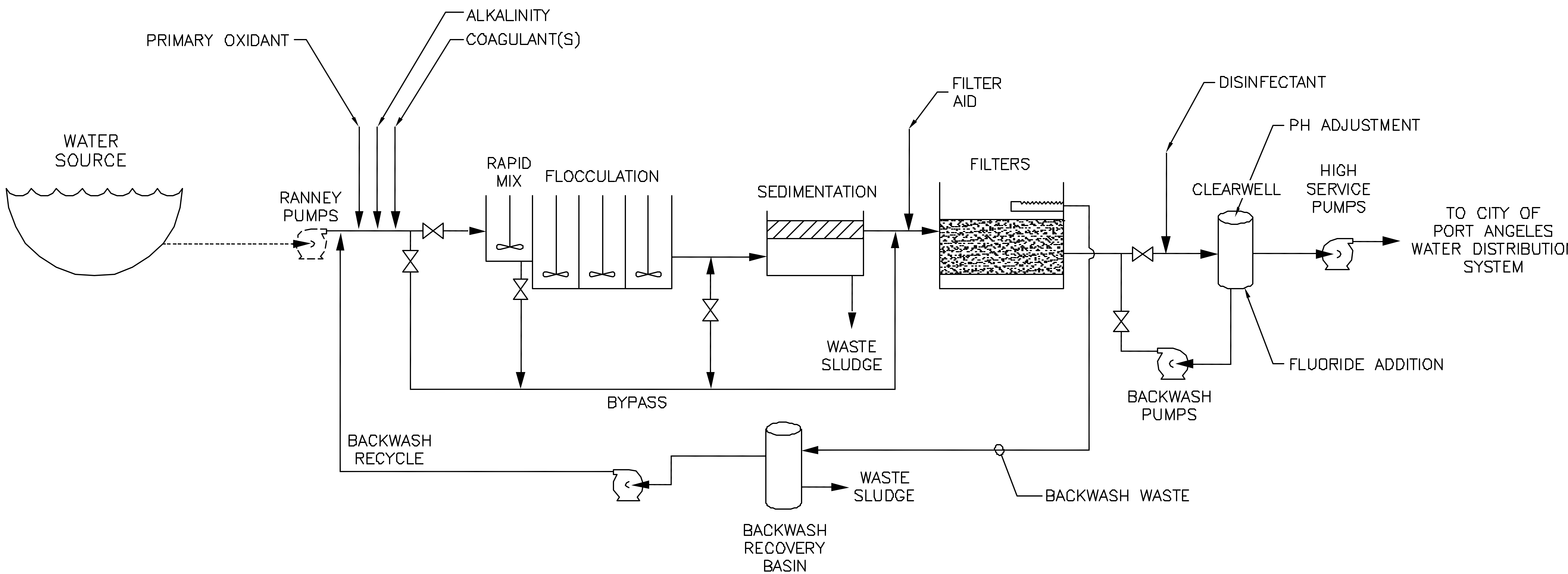
Conventional treatment generally refers to treatment processes consisting of coagulation, flocculation, sedimentation, and filtration. Figure 6.1 depicts a schematic of a typical conventional treatment process train. The design criteria for major unit process are listed below:

Unit Operation	Design Criteria	Range	Typical
1. Flash Mixing	Effective velocity Gradient G (0.5^1) x Mixing Time, T (gs)	300-1,200	1,000
2. Flocculation	Detention Time (t (min)	15-30	30
3. High-rate Settling (Sedimentation)	Surface Load (gpm/ft^2)	2.0-3.5	2.0
4. Filtration	Filtration Rate (gpm/ft^2)	1-6	3.0-3.5
	Backwash Rate (gpm/ft^2)	15-23	15
5. Disinfection	Chlorine Dosage (mg/L)	1 – 5	2

A primary oxidant may be used to control bacteria content, alga growth, taste, and odors. Iron and aluminum salts, such as ferric chloride or aluminum sulfate (alum), are commonly used to aid in coagulation of suspended solids to facilitate their removal by settling and filtration. Polymers may also be used in conjunction with or in place of metal salts. Both iron and aluminum salts consume a water's natural alkalinity and depress the pH of the water. Lime, soda ash, or caustic soda is typically added to supplement alkalinity, optimize the coagulation process, raise the pH, and reduce corrosiveness. The addition of coagulants is primarily used to remove suspended solids, but can also be used to remove TOC and color, or precipitate metals. The use of chemical coagulants to optimize the removal of TOC through flocculation and sedimentation is called enhanced coagulation.

Conventional treatment is commonly used for both surface water and groundwater sources, depending on the specific characteristics of the source water. The process can be easily adapted to a wide variety of source waters and can handle varying water qualities that may occur on a seasonal basis. After filtration, a final disinfectant (typically chlorine or chloramines) is added to reduce microbiological content to levels required by applicable health standards. Enhancements to the sedimentation process such as tube or plate settlers can be used to increase loading rates and enhance the efficiency of the process, resulting in smaller structure footprints and reduced structural costs. Filter backwash water is commonly recovered to conserve water and reduce the waste stream from the process that would require disposal.

Depending on the source, taste and odor problems may be treated using oxidants, powdered activated carbon, or other techniques. If dissolved iron and manganese become a problem, potassium permanganate, aeration, ozone, peroxide or chlorine are potential chemical treatment options.



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CONVENTIONAL TREATMENT PROCESS SCHEMATIC

FIGURE 6.1

With high quality source waters, the need for flocculation and sedimentation may not be required. The plant could operate as a direct filtration process that is discussed in the next section. The water quality on the Elwha River is expected to be excellent following dam removal and ecosystem recovery except during high run off periods, storms or similar events, as with current conditions. The operation of a conventional treatment plant as a direct filtration plant by by-passing the coagulation and sedimentation processes would reduce operation and maintenance costs during times when the source water quality is good. During high influent turbidity periods, the complete conventional treatment process would be used, particularly if a surface water intake was used to supplement the supply from the Ranney collector. The complete treatment process also provides multiple barriers to prevent the passage of cysts, viruses and similar contaminates to enhance the quality of the potable water from a public health viewpoint.

Treatment residuals are created in the conventional treatment process within the settling basin and during filter backwash and consist of chemical flocculent solids, sediment and similar residuals. The disposal of treatment residuals is discussed later in Section 6.6.

The estimated capital and annual operation and maintenance costs for a 10.6 mgd conventional water treatment plant are presented in Tables 6.2 and 6.3 respectively. For estimating purposes it was assumed that purchasing of liquid sodium hypochlorite (12.5% concentration) would be used for disinfection, and sedimentation ponds would be used for residuals handling. Both disinfection options and residuals handling options are discussed in subsequent sections. All municipal treatment cost estimating details are presented in Appendix E.

Advantages

- Effective for treating water sources with highly variable quality.
- Coagulation process can be optimized to remove suspended solids and turbidity, or optimized to remove TOC or color through enhanced coagulation.
- Tolerant to shock loads of high turbidity with manual or automatic controls to adjust chemical additives.
- Technology is widely used and accepted by regulatory authorities.
- Dissolved iron and manganese can be removed through chemical oxidation and settling process.
- Taste and odor problems can be corrected.
- Can be used as direct filtration plant with a consistent high quality source water.

Disadvantages

- Conventional treatment plants require large land area.
- Treatment residuals require dewatering and disposal
- Requires operator proficiency in water chemistry.
- Higher operation and maintenance complexity compared to membranes

Table 6.2

CONVENTIONAL WATER TREATMENT PLANT ESTIMATED CAPITAL COST

General Items for WTP	$3,616,000
Operations and Maintenance Facilities	$784,000
Flocculation/Sedimentation Complex	$2,569,000
Filter Complex	$1,649,000
Clearwell and Effluent Pumping Facilities	$1,312,000
Wash Water Recovery Basin	$729,000
Chlorine Building	$132,000
Decant Pump Station	$151,000
Sedimentation Ponds	$269,000
Subtotal	$11,211,000
Contingency (40%)	$4,484,000
Subtotal	$15,695,000
Engineering, Survey, and Construction Management (20%)	$3,139,000
Project Total	**$18,834,000**

Notes:
[1] Costs do not include purchase of land, easements, and similar.
[2] Costs are based on the first quarter of year 2001 prices.

Table 6.3

CONVENTIONAL WATER TREATMENT PLANT ESTIMATED ANNUAL O&M COST

	Total Annual Treatment Costs
Labor	$476,000
Operation	$245,000
Maintenance	$60,000
Professional Services	$45,000
Other	$55,000
Subtotal	$881,000
10% Contingency	$89,000
Total	**$970,000**

Note:
[1] Costs are based on the first quarter of year 2001 prices.

6.2.2 Direct Filtration

Raw water with turbidity, color, taste, and odor that are low or unobjectionable may be treated by direct filtration. Figure 6.2 depicts a schematic of a typical direct filtration process train.

This treatment process is very similar to conventional treatment but sedimentation and in some cases flocculation may be eliminated if the source water is of high quality. A chemical coagulant or filter aid may be required to improve the performance of the filters. Due to the elimination of the sedimentation basins, both the capital and operation and maintenance costs are considerably lower when compared to conventional treatment.

Direct filtration is traditionally used for consistently high quality water sources. The high anticipated fluctuations in water quality within the Elwha River during dam removal and the unknown performance of the Ranney collector as a prescreen, may make this treatment process less flexible and less reliable than other options.

Treatment residuals are created in the direct filtration process only during filter backwash, which results in substantially less residuals disposal than conventional treatment. The disposal of treatment residuals is discussed in Section 6.6.

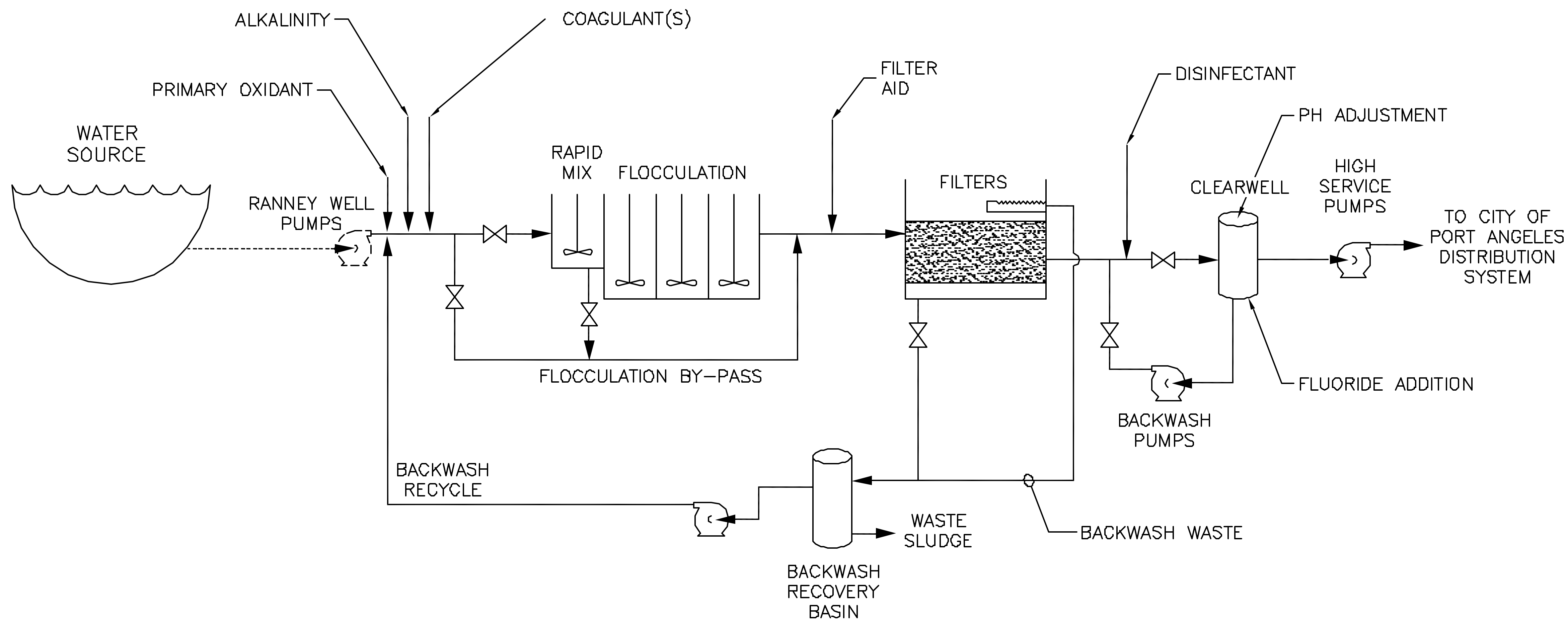
Estimated capital costs and annual operation and maintenance costs for a 10.6 mgd direct filtration plant are presented in Tables 6.4 and 6.5 respectively. For estimating purposes it was assumed that purchasing of liquid sodium hypochlorite (12.5% concentration) would be used for disinfection, and sedimentation ponds would be used for residuals handling. Both disinfection options and residuals handling options are discussed in subsequent sections. All municipal treatment cost estimating details are presented in Appendix E.

Table 6.4

DIRECT FILTRATION WATER TREATMENT PLANT ESTIMATED CAPITAL COST

General Items for WTP	$2,774,000
Operations and Maintenance Facilities	$784,000
Flocculation Complex	$669,000
Filter Complex	$1,624,000
Clearwell and Effluent Pumping Facilities	$1,312,000
Wash Water Recovery Basin	$729,000
Chlorine Building	$132,000
Decant Pump Station	$151,000
Sedimentation Ponds	$269,000
Subtotal	$8,444,000
Contingency (40%)	$3,378,000
Subtotal	$11,822,000
Engineering, Survey, and Construction Management (20%)	$2,364,000
Project Total	**$14,186,000**

Notes:
[1] Costs do not include purchase of land, easements, and similar.
[2] Costs are based on the first quarter of year 2001 prices.



DIRECT FILTRATION TREATMENT PROCESS SCHEMATIC

FIGURE 6.2

Table 6.5

DIRECT FILTRATION WATER TREATMENT PLANT ESTIMATED ANNUAL O&M COST

	Total Annual Treatment Costs
Labor	$476,000
Operation	$245,000
Maintenance	$60,000
Professional Services	$45,000
Other	$55,000
Subtotal	$881,000
10% Contingency	$88,000
Total	**$969,000**

Notes:
[1] Costs are based on first quarter of year 2001 prices.

Advantages

- Lower capital costs
- Less operation and maintenance cost and personnel time
- Less residuals disposal compared to conventional treatment
- Requires smaller land area than conventional treatment

Disadvantages

- Requires source water with consistently high quality
- Not suitable for high solids loading or highly varying water quality
- Requires higher level of operator attention to account for lower reliability
- May require known water quality for acceptance by WDOH

6.2.3 Membranes

Membranes represent a physical process for treating drinking water rather than a chemical process. Membrane processes are generally categorized according to driving force, membrane type and configuration, and removal capabilities. Those generally classified as pressure-driven processes include:

- Reverse Osmosis (RO)
- Nanofiltration (NF)
- Ultrafiltration (UF)

- Microfiltration (MF)

In these processes, pressurized feed water enters vessels containing membranes that are permeable to water molecules but preclude substances greater than a specified size. MF and UF processes separate substances from feed water through a sieving action. Separation depends on the membrane pore size and interaction with entrained material on the membrane surface. NF and RO processes separate substances through a thin, dense, semi-permeable membrane barrier as well as by sieving action. The required membrane feed pressure generally increases as removal capability increases.

Membrane processes classified as voltage-driven include:

- Electrodialysis (ED)
- Electrodialysis Reversal (EDR)

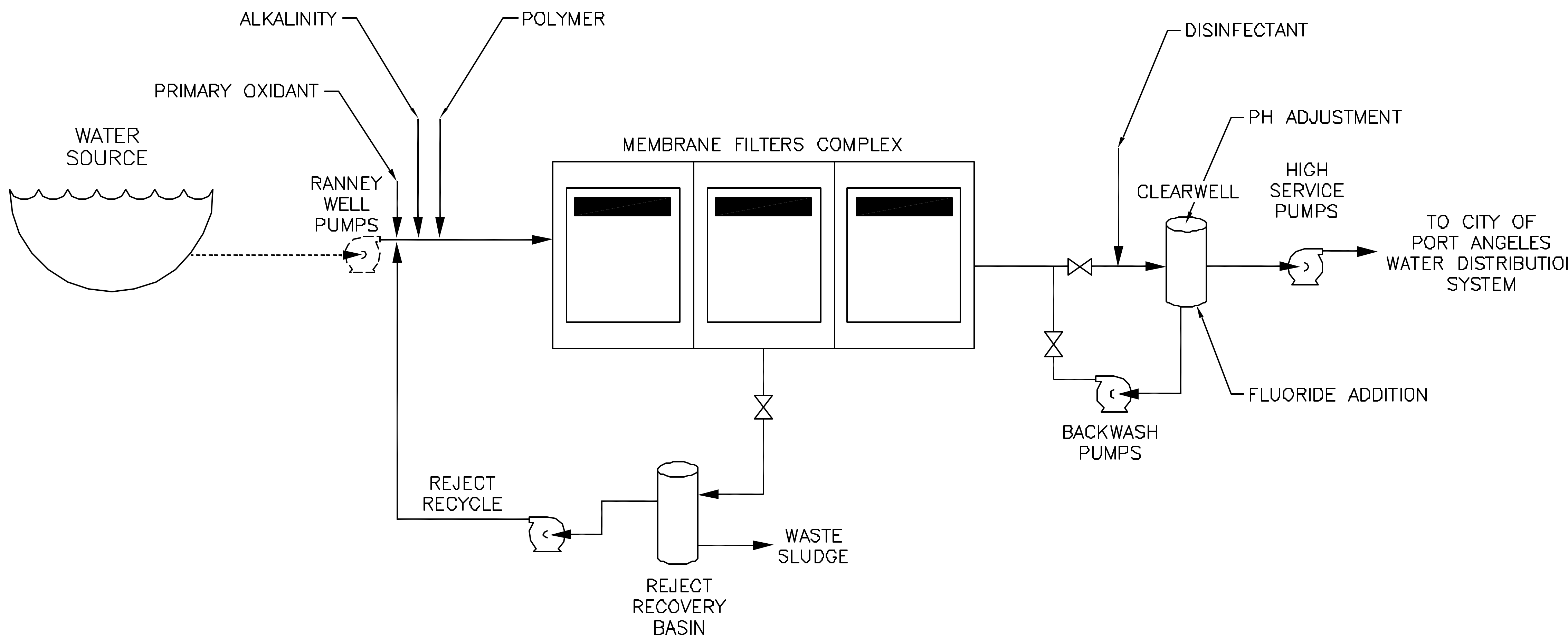
These processes utilize alternating anion and cation transfer ion exchange membranes in flat sheet form placed between positive and negative electrodes. The application of voltage across the electrodes results in positively charged ions moving towards the negative electrode and negatively charged ions moving towards the positive electrode. This effect causes alternating compartments to become demineralized and the other compartments to become concentrated with ions. EDR is a variation of the ED process where electrodes are reversed on a set frequency to “electrically flush” the membranes to control scaling and fouling.

The electrodialysis process is very costly and rarely used in municipal water treatment applications. The process is generally utilized for source waters high in salinity and would be applicable if a desalination plant was required as an alternative water source. Desalination is not considered a feasible alternative for either municipal or industrial treatment based on expense and complexity.

Based on a preliminary review of the current and expected source water quality and overall water treatment objectives, the membrane process using microfiltration was selected for further evaluation. Figure 6.3 depicts a schematic of a typical membrane treatment process.

Membranes typically process between 85-90% of the influent water. The remaining water is rejected as waste and can be further recovered with additional membranes or must be disposed. Typically this waste does not have any treatment chemicals present. Additional treatment residuals are created when the membranes are cleaned. This backwash water is typically acidic or basic and is usually treated prior to disposal. The amount of backwash water generated is significantly less than the quantity of reject water generated. The disposal of treatment residuals is discussed in Section 6.6.

Estimated capital costs and annual operation and maintenance costs for an 10.6 mgd membrane plant are presented in Tables 6.6 and 6.7 respectively. For estimating purposes it was assumed that purchasing of liquid sodium hypochlorite (12.5% concentration) gas would be used for disinfection, and sedimentation ponds would be used for residuals handling. Both disinfection options and residuals handling options are discussed in subsequent sections. All municipal treatment cost estimating details are presented in Appendix E.



NOTE:

1. FOR REMOVAL OF IRON MANGANESE, TOC, OR TASTE AND ODOR RAPID MIX, FLOCCULATION, AND SEDIMENTATION FACILITIES MAY BE REQUIRED PRIOR TO THE MEMBRANE FILTERS.

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MEMBRANE TREATMENT SCHEMATIC

FIGURE 6.3

Table 6.6

MEMBRANE TREATMENT PLANT ESTIMATED CAPITAL COST

General Items for WTP	$4,199,000
Operations and Maintenance Facilities	$784,000
Membrane Complex	$6,519,000
Clearwell and Effluent Pumping Facilities	$1,312,000
Wash Water Recovery Basin	$729,000
Chlorine Building	$132,000
Subtotal	$13,675,000
Contingency (40%)	$5,470,000
Subtotal	$19,145,000
Engineering, Survey, and Construction Management (20%)	$3,825,000
Project Total	**$22,970,000**

Notes:
[1] Costs do not include purchase of land, easements, and similar.
[2] Costs are based on the first quarter of year 2001 prices.

Table 6.7

**MEMBRANE TREATMENT PLANT
ESTIMATED ANNUAL O&M COST**

	Total Annual Treatment Costs
Labor	$476,000
Operation	$203,000
Maintenance	$60,000
Professional Services	$45,000
Other	$55,000
Subtotal	$839,000
10% Contingency	$84,000
Total	**$923,000**

Notes:
[1] Costs do not include purchase of land, easements, and similar.

Advantages

- Effective for treating sources of highly variable quality.
- Limited chemical handling or optimization of chemical dosing.
- Provides very effective removal of suspended solids, turbidity, and Giardia and Cryptosporidium-sized particles.

- Requires smaller footprint than most other forms of water treatment plants.
- Typically requires less manpower to operate.
- Reject water can be chemical free and potentially discharged to local water bodies.

Disadvantages

- Not effective for the removal of dissolved constituents in the water such as TOC, iron, and manganese without preliminary treatment.
- Bacteria, chlorine residual, and polymers can foul or damage membranes.
- Membrane backwash water may require further treatment prior to disposal.
- For low quality source waters, pretreatment requirements can be similar to those required for conventional treatment.

6.2.4 High Rate Treatment (Proprietary)

Two proprietary high rate flocculation/clarification systems were evaluated for municipal treatment alternatives. Systems evaluated were as follows:

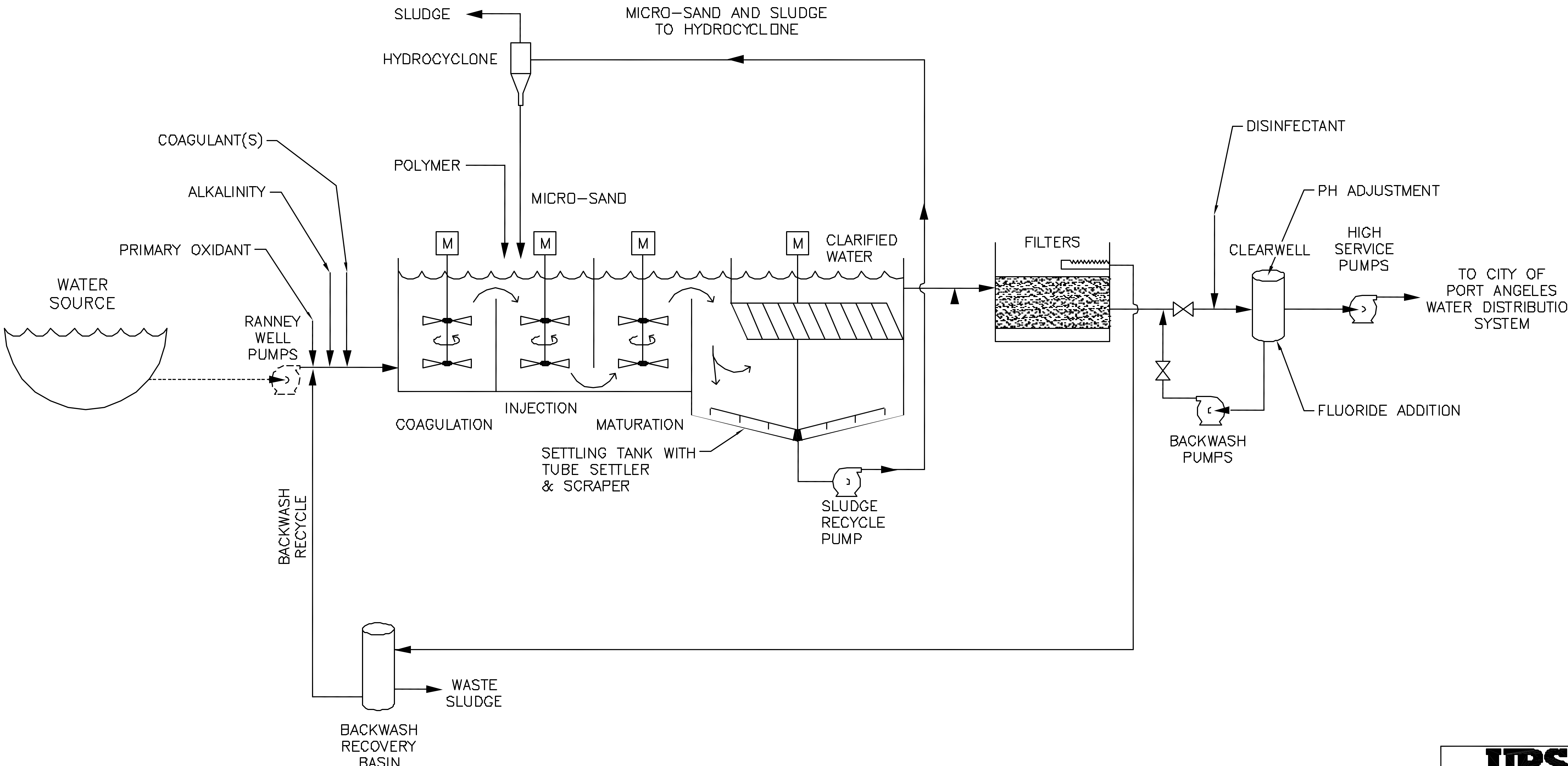
- Microsand ballasted coagulation clarification (ACTIFLO by US Filter)
- Pulsed blanket clarifier (Super Pulsator by Ondeo Degremont, Inc.)

6.2.4.1 ACTIFLO

The Actiflo process is a compact clarification system using microsand-enhanced flocculation and clarification. Figure 6.4 depicts a schematic of the Actiflo treatment process. The manufacturer's literature on the Actiflo process is included in Appendix F.

A coagulant such as alum is added to the untreated water in a separate coagulation tank. The coagulated water then enters a second tank called an injection tank where microsand (60-120 µm) and polymer are added. The microsand provides a large contact area and acts as ballast therefore accelerating the settling of floc. The destabilized suspended solids bind to the microsand through polymer bridges. In the third tank, the particles agglomerate together and grow into high density floc known as microsand ballasted floc that settle quickly to the bottom of the lamella tube settling tank. A filtration process is required following the Actiflo treatment. The filters would be the same size and design as used in the conventional treatment alternative.

The sludge/microsand mixture collected at the bottom of the settling tank is pumped to hydrocyclones where the sludge is separated from the microsand. The recovered microsand is then recycled to the injection tank whereas the separated sludge is continuously discharged to the solids handling process. The Actiflo process has been shown to utilize less coagulation chemicals than traditional conventional treatment plants and therefore typically produces fewer residuals that would require disposal. The disposal of treatment residuals is discussed in Section 6.6.



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ACTIFLO TREATMENT PROCESS SCHEMATIC

FIGURE 6.4

Like traditional conventional treatment plants, an Actiflo plant can be run as a direct filtration process if the water quality from the Ranney collector remains consistently high in quality. The Actiflo process has the flexibility of by-passing the coagulation, flocculation, and sedimentation basin if water quality permits, and thus decrease the operation and maintenance costs.

Estimated capital costs and annual operation and maintenance costs for an 10.6 mgd Actiflo plant are presented in Tables 6.8 and 6.9 respectively. For estimating purposes it was assumed that liquid sodium hypochlorite (12.5% concentration) would be used for disinfection, and sedimentation ponds would be used for residuals handling. Both disinfection options and residuals handling options are discussed in subsequent sections. All municipal treatment cost estimating details are presented in Appendix E.

Table 6.8

ACTIFLO WATER TREATMENT PLANT ESTIMATED CAPITAL COST

General Items for WTP	$3,183,000
Operations and Maintenance Facilities	$784,000
High Rate Clarification	$2,051,000
Filter Complex	$1,624,000
Clearwell and Effluent Pumping Facilities	$1,312,000
Wash Water Recovery Basin	$729,000
Chlorine Building	$132,000
Decant Pump Station	$151,000
Sedimentation Ponds	$269,000
Subtotal	$10,235,000
Contingency (40%)	$4,094,000
Subtotal	$14,329,000
Engineering, Survey, and Construction Management (20%)	$2,866,000
Project Total	**$17,195,000**

Notes:
1 Costs do not include purchase of land, easements, and similar.
2 Costs are based on the first quarter of year 2001 prices.

Table 6.9

ACTIFLO WATER TREATMENT PLANT ESTIMATED ANNUAL O&M COST

	Total Annual Treatment Costs
Labor	$476,000
Operation	$235,000
Maintenance	$60,000
Professional Services	$45,000
Other	$55,000
Subtotal	$871,000
10% Contingency	$87,000
Total	**$958,000**

Notes:
1 Costs do not include purchase of land, easements, and similar.

Advantages

- Effective at treating source waters of highly variable quality including low turbidity water
- Lower capital cost than traditional conventional treatment
- Power costs are comparable to traditional conventional treatment
- Less chemical coagulants typically required, that translates to lower chemical costs
- Less treatment residuals typically generated
- Smaller facility footprint compared to traditional conventional treatment
- Maybe shutdown and restarted quickly
- Provides same flexibility as traditional conventional treatment for removal of dissolved constituents and treatment of high turbidity spikes
- Can be operated as a direct filter plant to reduce O&M costs if source water quality permits

Disadvantages

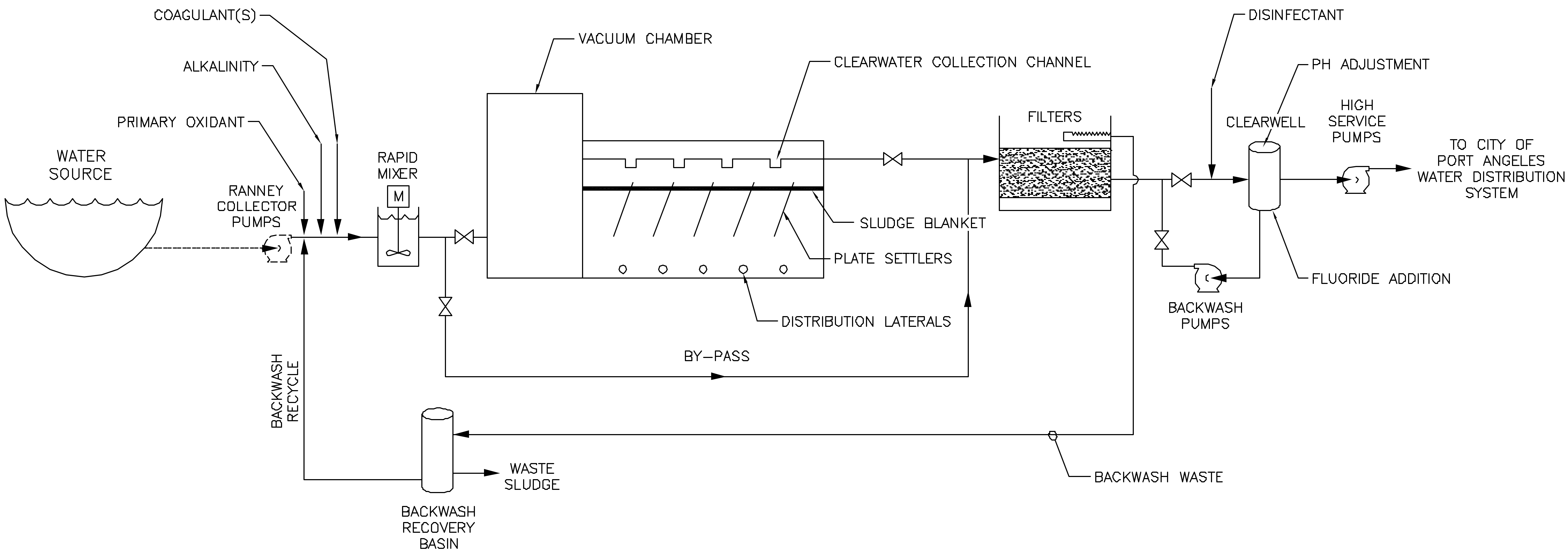
- Treatment residuals require dewatering and disposal
- Requires operator proficiency in water chemistry
- Higher operation and maintenance complexity compared to membranes

6.2.4.2 SUPER PULSATOR

The Super Pulsator is a high-rate clarifier that combines clarification and flocculation in the same treatment unit. Figure 6.5 depicts a schematic of the Super Pulsator treatment process.

A coagulant is added to the untreated water prior to rapid mixing. The coagulated water is then directed into a sealed vacuum chamber that controls flow into the clarifier's distribution duct. From the distribution duct, the water flows to distribution laterals that are evenly spaced over the clarifier floor. Vacuum pumps in the vacuum chamber cause the water level to rise. A timer-actuated vent valve vents the vacuum chamber to atmosphere. As the water level falls in the vacuum chamber, a pulse of water uniformly expands the entire surface of the sludge blanket, which is comprised of previously formed solids. The clarified effluent is collected in evenly spaced laterals that span the clarifier surface and connect to the effluent collection channel. Sludge concentrators, which also act as internal weirs, control the height of the sludge blanket and collect sludge. The concentrators are periodically emptied via sludge collection piping. The disposal of treatment residuals is discussed in Section 6.6.

Estimated capital costs and annual operation and maintenance costs for an 10.6 mgd Super Pulsator plant are presented in Tables 6.10 and 6.11 respectively. For estimating purposes it was assumed that the purchasing of liquid sodium chloride (12.5% concentration) would be used for disinfection, and sedimentation ponds would be used for residuals handling. Both disinfection options and residuals handling options are discussed in subsequent sections. Municipal treatment estimating details are presented in Appendix E.



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SUPER PULSATOR TREATMENT PROCESS SCHEMATIC

FIGURE 6.5

Table 6.10

SUPER PULSATOR TREATMENT PLANT ESTIMATED CAPITAL COST

General Items for WTP	$2,928,000
Operations and Maintenance Facilities	$784,000
Rapid Mixing Complex	$166,000
High Rate Clarification	$1,531,000
Filter Complex	$1,624,000
Clearwell and Effluent Pumping Facilities	$1,312,000
Wash Water Recovery Basin	$729,000
Chlorine Building	$132,000
Decant Pump Station	$151,000
Sedimentation Ponds	$269,000
Subtotal	$9,626,000
Contingency (40%)	$3,850,000
Subtotal	$13,476,000
Engineering, Survey and Construction Management (20%)	$2,695,000
Project Total	**$16,171,000**

Notes:
[1] Costs do not include purchase of land, easements, and similar.
[2] Costs are based on the first quarter of year 2001 prices.

Table 6.11

SUPER PULSATOR TREATMENT PLANT ESTIMATED ANNUAL O&M COST

	Total Annual Treatment Costs
Labor	$476,000
Operation	$245,000
Maintenance	$60,000
Professional Services	$45,000
Other	$55,000
Subtotal	$881,000
10% Contingency	$89,000
Total	**$970,000**

Notes:
[1] Costs do not include purchase of land, easements, and similar.

Advantages

- No under water moving parts
- Each process train requires only one basin
- Requires 1 hp per mgd of water treated
- Sludge blanket allows some fluctuation in influent turbidity
- PAC will be retained for a longer detention time in sludge blanket and hence is more efficiently used
- Uniform distribution of flocculation energy (reduced short circuiting)
- Sludge blanket cannot be lost due to operator error or malfunction of sludge blowdown system
- Smaller footprint compared to conventional treatment plant
- Ability to operate without polymer at lower hydraulic loading, rate

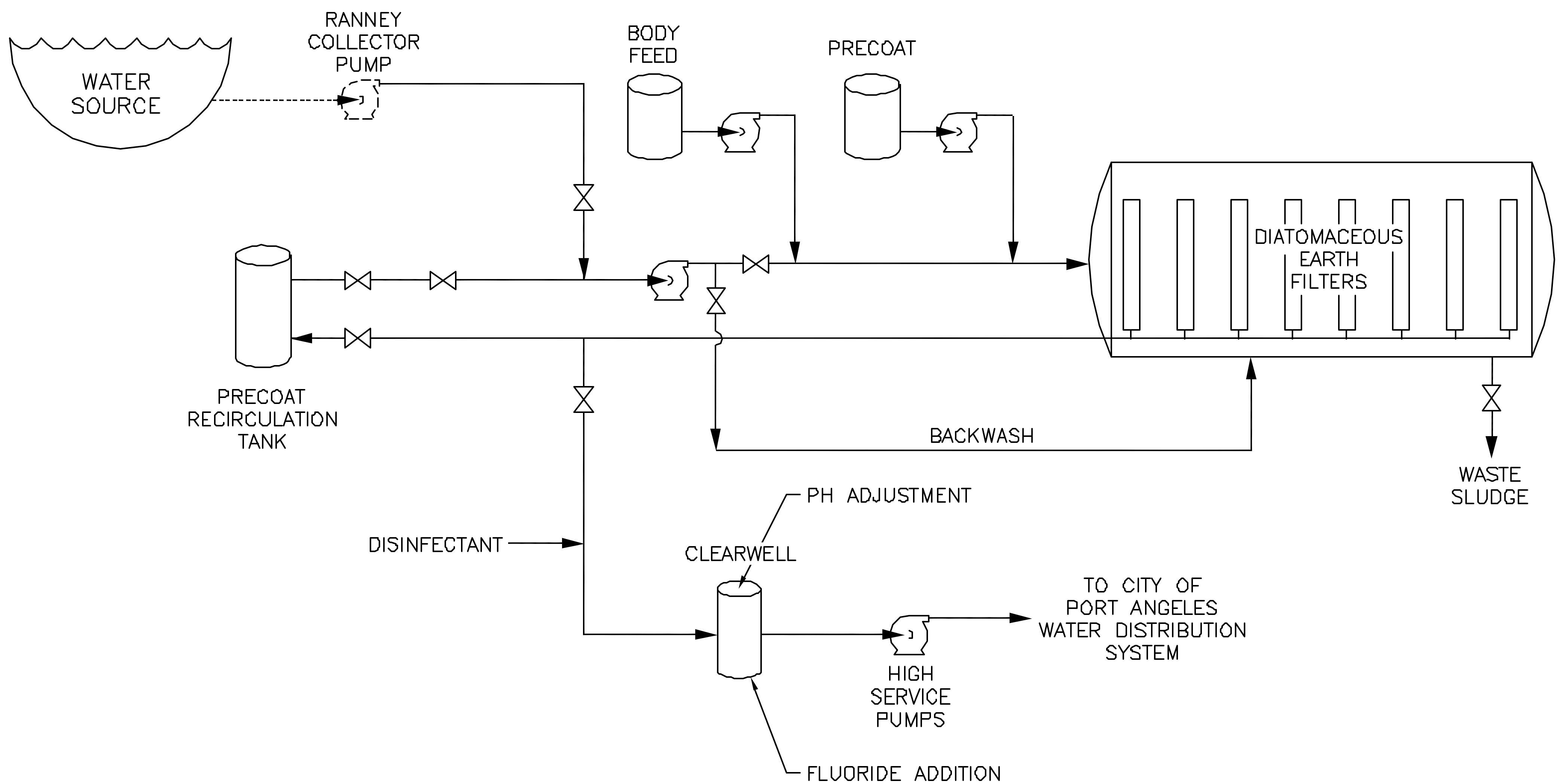
Disadvantages

- Treatment residuals require dewatering and disposal
- Requires operator proficiency in water chemistry
- Higher operation and maintenance complexity compared to membranes
- Treatment can be adversely affected by sudden change in water temperature
- Operation must be continuous to maintain the sludge blanket and treatment
- Difficult to maintain treatment for initially low turbidity water

6.2.5 Diatomaceous Earth Filters

Diatomaceous earth (DE) filters, the most common type of precoat filters, have been used effectively for the treatment of drinking water since 1942. In that year the U.S. Army adopted the process as a standard method of treatment largely due to its effectiveness in removing cysts. The precoat operation draws its name from the process of coating filter leaves with approximately 1/8" of material at the initiation of each filter operating cycle. Although diatomaceous earth, mined from the fossilized remains of microscopic plants called diatoms, is the most common precoat material used, other precoat materials such as ground perlite performs well in other applications. Figure 6.6 depicts a schematic of a DE treatment process.

In the DE filtration process, untreated water is passed through a uniform layer of the filter media that has been deposited (precoated) on a septum, a permeable material that supports the filter media. As the untreated water passes through the filter media (diatomaceous earth) and the septum, most of the suspended particles are removed and remain at the surface of the filter media layer. As the filter process continues, additional filter media, called body feed, is metered into the influent to maintain the permeability of the filter media as the process continues and the thickness of the media and accumulated filtered material (cake) increases. At a point that the



DIATOMACEOUS EARTH TREATMENT PROCESS SCHEMATIC

FIGURE 6.6

cake reaches a thickness where continued filtration is impractical due to the increasing pressure to push water through the media, the cake is removed and disposed. A new layer of precoat is reapplied on the septum and the filtration process starts over. The primary sources of DE are located in California.

Treatment residuals consist of the diatomaceous earth filter media and filtered solids. The disposal of treatment residuals is discussed in Section 6.6.

There are generally two basic groups of DE filter systems. Those that force water through the filter under pressure are enclosed vessels. Filters operated under vacuum may utilize open vessels.

Estimated capital costs and annual operation and maintenance costs for an 10.6 mgd typical pressure driven DE filtration system are presented in Tables 6.12 and 6.13 respectively. For estimating purposes it was assumed that purchasing of liquid sodium hypochlorite (12.5% concentration) would be used for disinfection, and sedimentation ponds would be used for residuals handling. Both disinfection options and residuals handling options are discussed in subsequent sections. Municipal treatment cost estimating details are presented in Appendix E.

Table 6.12

DIATOMACEOUS EARTH WATER TREATMENT PLANT ESTIMATED CAPITAL COST

General Items for WTP	$3,090,000
Operations and Maintenance Facilities	$784,000
Diatomaceous Earth Complex	$3,742,000
Clearwell and Effluent Pumping Facilities	$1,312,000
Chlorine Building	$132,000
Subtotal	$9,060,000
Contingency (40%)	$3,624,000
Subtotal	$12,684,000
Engineering, Survey, and Construction Management (20%)	$2,537,000
Project Total	**$15,221,000**

Notes:

1 Costs do not include purchase of land, easements, and similar

2 Cost are based on the first quarter of year 2001 prices

Table 6.13

DIATOMACEOUS EARTH WATER TREATMENT PLANT ESTIMATED ANNUAL O&M COSTS

	Total Annual Treatment Costs
Labor	$420,000
Operation	$281,000
Maintenance	$35,000
Professional Services	$45,000
Other	$55,000
Subtotal	$836,000
10% Contingency	$84,000
Total	**$920,000**

Notes:

[1] Costs do not include purchase of land, easements, and similar

Advantages

- Treatment costs may be considerably less than conventional treatment since coagulation, sedimentation, and granular media filtration are not required.
- No chemical handling or optimization of chemical dosing.
- The waste filter media is easily dewatered, and in some cases can be reclaimed for other uses such as soil conditioning or landfill cover.
- Effective in Giardia and similar small particle removal.

Disadvantages

- Generally more effective in high quality surface waters with turbidities less than 10 NTU. The process is not suitable for algae, color, taste, dissolved organics or soluble iron and manganese problems without conventional rapid mix, flocculation, and sedimentation facilities preceding the filters.
- Desired results require proper operation with respect to the application and replenishing of the filter cake.
- Pressurized process requiring added pumping costs.
- Filters are subject to shut down then recoating with DE after any power disruption or substantial pressure fluctuation.
- Filter is enclosed and process and status of DE coating is not visible to the operator.

6.2.6 Slow Sand Filters

Slow sand filters are sand filters operated at very low filtration rates without the use of a coagulant. In a typical slow sand filter, most of the solids are removed in a thin layer on top of the filter bed. This layer, composed of dirt and living and dead micro- and macro-organisms from the untreated water (the schmutzdecke), becomes the dominant filter medium in the process. Slow sand filters have cycle lengths varying from 1 to 6 months and are periodically cleaned as head loss through the filter rises. Cleaning is by draining and physically removing the schmutzdecke and up to 2 inches of sand. After a number of cleanings the sand is replenished.

The filtration rate of slow sand filters is 50 to 100 times slower than that of ordinary rapid sand and high-rate filters. Consequently, land requirements are significant. The filter area required for a 10.6 mgd plant would be approximately up to 3.4, acres this does not include the support buildings, disinfectant process, or treatment residuals disposal. The filters would also need to covered. Slow sand filters for treatment capabilities of 10.6 mgdl are not common because of the land requirements. Slow sand filters are not considered a feasible alternative for the City of Port Angeles municipal supply.

6.3 RECOMMENDED TREATMENT OPTION

Table 6.14 is a summary of the capital cost, annual operation and maintenance costs, advantages, and disadvantages of each of the municipal treatment technologies discussed in Section 6.2. Slow sand filters have been excluded from this summary because it was determined that this technology was unfeasible based on the required filter area.

Table 6.14 also includes the present worth value of the capital and operating cost of each treatment option.

Table 6.14

SUMMARY OF MUNICIPAL TREATMENT ALTERNATIVES

Treatment Process	Capital Cost[1]	O&M Cost[1]	20 Year Present Worth[2]	Advantages	Disadvantages
Conventional Treatment	$18,834,000	$970,000	$29,960,000	• Effective for treating water sources with highly variable quality. • Coagulation process can be optimized to remove suspended solids and turbidity, or optimized to remove TOC or color through enhanced coagulation. • Tolerant to shock loads of high turbidity with manual or automatic controls to adjust chemical additives. • Technology is widely used and accepted by regulatory authorities. • Dissolved iron and manganese can be removed through chemical oxidation and flocculation and settling process. • Taste and odor problems can be removed.	• Conventional treatment plants require large land area. • Treatment residuals require dewatering and disposal • Requires operator proficiency in water chemistry. • Higher operation and maintenance complexity compared to membranes

Treatment Process	Capital Cost[1]	O&M Cost[1]	20 Year Present Worth[2]	Advantages	Disadvantages
				• Can be used as direct filtration plant with a consistent high quality source water.	
Direct Filtration	$14,186,000	$969,000	$25,300,000	• Lower capital costs • Less operation and maintenance cost and personnel time • Less residuals disposal compared to conventional treatment • Requires smaller land area than conventional treatment	• Requires source water with consistently high quality • Not suitable for high solids loading or highly varying water quality • Requires higher level of operator attention to account for lower reliability • May require known water quality for acceptance by WDOH
Membranes without Pretreatment	$22,970,000	$923,000	$33,557,000	• Effective for treating sources of highly variable quality. • Limited chemical handling or optimization of chemical dosing. • Provides very effective removal of suspended solids, turbidity, and Giardia and Cryptosporidium-sized particles. • Requires smaller footprint than most other forms of water treatment plants. • Typically requires less manpower to operate. • Reject water can be chemical free and potentially discharged to local water bodies.	• Not effective for the removal of dissolved constituents in the water such as TOC, iron, and manganese without preliminary treatment. • Bacteria, chlorine residual, and polymers can foul or damage membranes. • Membrane backwash water may require further treatment prior to disposal. • For low quality source waters, pretreatment requirements can be similar to those required for conventional treatment.
Membranes with Pretreatment	$27,289,000	$978,000	$38,507,000		
Actiflo	$17,195,000	$958,000	$28,183,000	• Effective at treating source waters of highly variable quality including low turbidity water • Lower capital cost than traditional conventional treatment • Power costs are comparable to traditional conventional treatment • Less chemical coagulants typically required, that translates to lower chemical costs • Less treatment residuals typically generated • Smaller facility footprint compared to traditional conventional treatment • Maybe shutdown and restarted quickly • Provides same flexibility as traditional conventional treatment for removal of dissolved constituents and	• Treatment residuals require dewatering and disposal • Requires operator proficiency in water chemistry • Higher operation and maintenance complexity compared to membranes

Treatment Process	Capital Cost[1]	O&M Cost[1]	20 Year Present Worth[2]	Advantages	Disadvantages
				treatment of high turbidity spikes • Can be operated as a direct filter plant to reduce O&M costs if source water quality permits	
Super Pulsator	$16,171,000	$970,000	$27,297,000	• No under water moving parts • Each process train require only one basin • Requires 1 hp per mgd of watch treated • Sludge blanket allows some fluctuation in influent turbidity • PAC will be retained for a longer detention time in sludge blanket and hence is more efficiently used • Uniform distribution of flocculation energy (reduced short circuiting) • Smaller footprint compared to conventional treatment plant • Ability to operate without polymer at lower hydraulic loading, rate	• Treatment residuals require dewatering and disposal • Requires operator proficiency in water chemistry • Higher operation and maintenance complexity compared to membranes • Treatment can be adversely affected by sudden changes in water temperature • Operation must be continuous to maintain the sludge blanket and treatment • Difficult to maintain treatment for initially low turbidity water
Diatomaceous Earth	$15,221,000	$920,000	$25,773,000	• Treatment costs may be considerably less than conventional treatment since coagulation, sedimentation, and granular media filtration are not be required. • No chemical handling or optimization of chemical dosing • The waste filter medium is easily dewatered, and in some cases can be reclaimed for other uses such as soil conditioning or landfill cover. • Effective in Giardia and similar small particle removal.	• Generally more effective in high quality surface waters with turbidities less than 10 NTU. The process is not suitable for algae, color, taste, dissolved organics or soluble iron and manganese problems without conventional rapid mix, flocculation and sedimentation facilities preceding the filters. • Desired results require proper operation with respect to the application and replenishing of the filter cake. • Pressurized process requires added pumping costs. • Filters are subject to shutdown then recoating after any electric power disruption or substantial fluctuation of pressure.
Diatomaceous Earth with Preliminary Treatment	$19,536,000	$975,000	$30,719,000		

Notes:

[1] Treatment process costs assume that:

[a.] purchasing liquid sodium hypochlorite (12.5%), however, other disinfection alternative costs such as sodium hypochlorite, on-site generator, using chlorine gas, and UV disinfection are provided in Section 6.5, Recommended Disinfection Option;

[b.]residual disposal through sedimentation pond and landfill, however, the cost for using gravity thickener plus belt filter and landfill is provided in Section 6.7 recommended Treatment Residual Disposal.

[c] costs are based on the first quarter of year 2001 prices and do not include purchase of land, easements, and similar.

[2] Present worth is based on annual compounding discount rate of 6% for a 20-year period.

[3] The costs for both membrane and diatomaceous earth in this table are based on no pretreatment facilities being used. Pretreatment includes a rapid mix unit, and flocculation/sedimentation prior to the filter unit. To consider these pretreatment costs, use the following table:

Treatment Process	Subtotal	Construction Contingency 40%	Engineering Etc. 20%	Total	20-year Present Worth
Membrane in the table above	$13,675,000	$5,470,000	$3,829,000	$22,970,000	$33,557,000
Membrane with pretreatment facilities	$16,243,700	$6,497,500	$4,548,000	$27,289,200	$38,507,000
Diatomaceous earth in the table above	$9,060,000	$3,624,000	$2,537,000	$15,221,000	$25,776,000
Diatomaceous earth with pre-treatment facilities	$11,629,000	$4,651,000	$3,256,000	$19,536,000	$30,719,000

The recommended process for municipal treatment is a coagulation-sedimentation-filtration process to treat water from the City's existing Ranney collector or surface water. There are three such treatment processes described above, the "traditional" conventional treatment plant, the Actiflo ballasted flocculation treatment plant, and the high rate clarifier Super Pulsator process. All of these processes use coagulation chemistry followed by filtration to treat water, which allows for the greatest flexibility and reliability for treating a source water of unknown or highly variable quality. The major difference is the way each of these processes get suspended particles to coagulate and then settle. Either the conventional treatment or one of the high rate conventional treatment processes would be a technically appropriate treatment process to mitigate against the adverse impacts of dam removal, and these processes would meet all of the requirements of the SWTR, but at this time URS recommends the Actiflo process over all of the other treatment process investigated for the following reasons:

- Lower capital cost than traditional conventional treatment
- Lower chemical cost
- Smaller facility footprint
- Ease of operation
- Ability to treat both high and low turbidity water
- Higher treatment performance in side by side comparison
- Similar power cost

To confirm the recommendation of Actiflo over the other high rate process Super Pulsator, URS visited and made telephone contacts of existing operations of these two high rate treatment processes and potential pilot testing to determine the following:

- Cost of operation
- Ease of operation
- Stability of the process
- Chemical usage
- Performance at high and low TSS levels
- Sludge characteristics and volume
- Loss of sand for Actiflo
- Capability to remove iron, manganese, color, taste and odor

The Super Pulsator plant in Green River Wyoming and the Actiflo plant in Golden, Colorado were visited by URS, Reclamation, and City personnel. URS contacted two other Super Pulsator plants in North Carolina. The visits and telephone contacts indicated that the Actiflo process is better suited to the Elwha River application due to its ability to treat low turbidity water without extensive operator attention and because it can be turned off and restarted with the process operating in a stable mode in typically less than 30 minutes. The ease of operation for Actiflo was apparent and loss of sand was not indicated as significant at the Golden facility.

Pilot testing of the Actiflo process will be used to satisfy the DOH requirement for testing treatment processes and confirm its suitability for the Elwha River application.

The conceptual level cost estimate of the two alternatives showed that a 10.6 mgd Actiflo plant is approximately $1.6 million less expensive to construct than a conventional treatment plant. Much of the cost savings are due to the smaller size of the treatment basins, facility structure, and land requirements.

Significant information has been developed on the performance of the Actiflo process compared to conventional treatment plants. This information has been supplied by the manufacturer and reviewed by URS. The comparison information is presented in Appendix F.

According to the information, the combination of efficient mixing and microsand ballasted flocculation make Actiflo very effective in treating low temperature, low turbidity raw water that is often difficult to coagulate using traditional methods. Actiflo is often capable of producing <1 NTU clarified water from a wide range of raw water turbidities. The ability to effectively remove turbidity prior to the filters from difficult to treat influent results in lower filter loading and increased filter run-times.

The advantages of microsand enhanced flocculation provide for consistently high quality clarified water under a variety of treatment conditions including significant unexpected turbidity spike events or seasonally changing water conditions. The Actiflo process has also been shown to effectively treat extremely high, sudden turbidity spikes. The use of microsand in the process results in a relatively constant suspended solids concentration in the system, thus, extremely high or sudden suspended solids concentrations are effectively dampened by the already high suspended solids concentration normally maintained within the process. The overall result is stable treatment performance at influent water turbidities in excess of 1,000 NTU.

Studies were performed to compare the amount of coagulation chemicals required for the Actiflo process compared to conventional treatment for a variety of source waters in the United States. The studies showed a 30-50% reduction in the amount of alum required to effectively clarify the untreated water. This can translate into a significant operation and maintenance cost savings.

Like conventional treatment, the chemical dosing in an Actiflo plant can be optimized to remove iron, manganese and/or TOC. In fact, studies comparing Actiflo to conventional treatment for the removal of TOC for various water sources in the United States and Canada show that Actiflo was capable of reducing TOC by 17-78% while conventional treatment could only obtain 8-49% reductions (see Appendix F).

A study was conducted on a 10 mgd treatment plant in Golden, Colorado to determine the power requirement of the Actiflo process compared to the conventional plant. The conventional plant had a 5 horsepower (hp) flash mixer, and a 1 hp flocculation motor. The Actiflo plant, treating the same amount of water, required a 3 hp coagulation motor, a 3 hp injection tank motor, a 5 hp maturation tank motor, a 1 hp scraper, and 2-5 hp sand slurry pumps. The comparison was conducted for nine months and found that the power costs for the two processes were relatively identical despite the increased hp required for Actiflo. The reason for this was that the amount of backwash water for the Actiflo plant is less than that for the conventional plant. All the filter backwash water was pumped using a 75 hp motor. The filter turbidity loading of the Actiflo process was considerably less than for conventional treatment, because of the effectiveness of Actiflo to reduce turbidity levels to below 1 NTU through clarification before filtration. The less turbidity that goes onto the filter means the less backwashing and cleaning required. These longer filter runs resulted in reduced power consumption.

The Actiflo process would be followed by filtration through a multi or dual-media filter. The filter media consists of at least anthracite, sand and gravel layers. In order to clean the filter, an air-water backwashing system would be developed to fluidize the media bed and flush out filtered particles for disposal. The disposal of the treatment residuals is discussed in Section 6.6.

It was assumed that the chemicals used for the coagulation and flocculation would be caustic soda, alum and polymer. Provisions for alkalinity adjustments have not been provided for in the preliminary design or costing. The need to use alkalinity adjustments in the treatment process can be determined through laboratory bench scale testing during the design phase and added to the final design.

The existing Ranney collector has a capacity of 10.7 mgd (16.6 cfs) which meets the projected 20-year demand as described in Section 4. The Actiflo plant will treat water from this existing collector. A cross connection to the industrial intake facilities will be provided to supplement a potential reduction in yield from the existing Ranney collector. The Actiflo process will meet all the treatment requirements of the SWTR and be capable of treating Elwha River surface water if required. The cross connection from the proposed industrial intake and the municipal system are shown on the industrial intake figures.

6.4 DISINFECTION OPTIONS

Disinfection technologies readily available and in common use each have their strengths and weaknesses in treating municipal drinking water. The following section describes some of the available disinfection technologies. Along with the brief profiles of the varying technologies, factors such as their relative effectiveness, formation of disinfection by-products (DBPs), operational complexity, safety risk and relative cost are summarized in Table 6.15.

6.4.1 Chlorine Gas (Bulk Liquid)

A chlorine gas disinfection system is currently in use by the City of Port Angeles. Chlorine gas is produced at chlor-alkali plants and shipped to water treatment plants as a liquid in pressurized bulk containers. For more than a century chlorine gas has been used successfully to disinfect drinking water. When added to water, chlorine forms hypochlorous acid, an active disinfectant.

The main capabilities of this disinfectant are:

- Destruction of a broad range of microorganisms, including bacteria, viruses and some protozoa.

- Controls many taste, color and odor problems in untreated water by oxidation of constituents that cause these problems.
- With proper dosages, remains as chlorine residual in water distribution systems to protect against growth of biofilm or microorganisms. This residual can serve as an indicator of water quality.

Chlorine gas is the most widely used form of disinfection used in the United States. Although chlorine gas has a broad range of capabilities at a cost-effective price, there are concerns associated with the hazards of transportation and storage of chlorine gas, the possible creation of harmful DBP's, and its weakness in inactivating Cryptosporidium.

Chlorine gas can also be generated on-site to eliminate the risk of transportation. Due to the high capital costs and operation and maintenance issues associated with having a small chemical plant on-site, chlorine gas generation for the City of Port Angeles was not considered feasible.

A comparison of chlorine gas compared to other disinfectants is presented in Table 6.15.

Table 6.15

COMPARISON OF DISINFECTION PROCESSES

Disinfection Process	Disinfection Effectiveness			By-Product Formation			Oxidation	Safety Risk	Complexity	Cost[2] $/gal
	Bact/ Virus	Cysts	Residual	Organic	Brominated	Inorganic				
Chlorine Gas	Very Good	Fair	Good	High	High	No	Good	High	Low	6
Hypochlorite	Very Good	Fair	Good	High	High (Bromate)	High	Good	Medium	Low	9
Chloramines	Fair	Very Poor	Excellent	Medium	No	No	Poor	Low	Medium	9
Ozone	Excellent	Excellent	No	Low	High (Bromate)	Medium	Very Good	High	High	130
Ultraviolet	Good	(Under Study)	No	No	No	No	--	Low	Low	60

1. Table from *Water Engineering & Management*, January 2001, Vol. 148, No. 1, pp. 13-16.
2. Relative cost comparison, cost dependant on installation size.

6.4.2 Hypochlorites

Both sodium hypochlorite, and calcium hypochlorite offer an excellent alternative approach to disinfection. The active ingredient in both compounds is the hypochlorite ion, which hydrolyzes to form hypochlorous acid.

Sodium hypochlorite (bulk liquid), often called liquid bleach, is considered to the second cheapest disinfectant after bulk liquid chlorine gas. Commercially available as a 12.5% solution, it offers most of the advantages of chlorine gas yet it does not have transportation or storage hazards to the extent present with chlorine gas.

Bulk sodium hypochlorite has two problems. First, it tends to decompose in storage depending on the storage temperature, its age, concentration, and contaminants it may contain. A much larger issue is the possible presence of bromates, this EPA-regulated DBP can come from bromide impurities that may be in the sodium chloride from which sodium hypochlorite is made.

On-site generation of sodium hypochlorite is possible but has a high initial capital cost and requires routine maintenance. On-site generation of sodium hypochlorite was not considered feasible for Port Angeles.

Calcium hypochlorite is normally delivered to water treatment plants in a powder or granular form and mixed with water for application. It is often supplied in bags, briquettes, or other solid forms that are used in erosion type feeders. In smaller quantities, it about twice as expensive as sodium hypochlorite. Nonetheless, it is often preferred, primarily in smaller water treatment plants, because it is more stable and produces far less inorganic DBPs. In smaller amounts, it also is easier to handle and store.

Calcium hypochlorite requires special storage care to avoid contact with organic materials. These two substances can generate enough heat and oxygen to start a fire. When mixed with water, calcium hypochlorite causes an exothermic reaction and hence may create a hazard. To prevent excessive heat, the dry chemical should always be added to the correct amount of water, rather than water added to the chemical.

A comparison of hypochlorites to other disinfectants is presented in Table 6.15.

6.4.3 Chloramines (Ammonia-Chlorine Process)

This process involves the addition of ammonia and chlorine compounds separately to a water treatment system. The two ingredients (usually, anhydrous ammonia and hypochlorous acid) react to form chloramines. The ingredients also can be ammonium salts and liquid hypochlorites. This treatment procedure also is called chloramination or the chloramine process.

Compared to chlorine gas, using chloramines as the primary disinfectant produces fewer DBPs and does not combine with organics in the water to form trihalomethane. The chloramine process may be used as secondary disinfectant to provide a longer lasting residual in the distribution system, if desired.

A comparison of chloramines to other disinfectants is presented in Table 6.15.

6.4.4 Chlorine Dioxide

Chlorine dioxide is usually produced on-site by mixing chlorine gas with sodium chlorite. It is recognized as an efficient oxidizer and a broad-spectrum, fast acting biocide. It is used primarily for pretreatment of surface waters that have odor and taste problems, or are high in manganese content. Chlorine dioxide cannot be transported as a compressed gas; it has to be generated on-site. Its use and generation requires skilled operators, further laboratory analyses, and additional chemical storage, which add to a higher operating costs, therefore, chlorine dioxide is not considered a feasible alternative for Port Angeles.

6.4.5 Ozone

Ozone is the most powerful disinfectant of those used in water treatment. However, ozone is highly unstable in water and does not provide a long term residual. A secondary disinfectant (chlorine) is often required for distribution protection. Ozone is a very strong oxidizing agent as well as a broad range biocide. It is very unstable and must be generated on-site. One method is to pass dry air or oxygen through a high-voltage electrical discharge. It is the most expensive of the chemical disinfectants. Ozone is excellent for the following:

- Inactivating all pathogenic organisms – bacteria, viruses, as well as the protozoa, Giardia and Cryptosporidium.
- Eliminating bad taste, odor, and color of water by oxidizing the offending organic and inorganic constituents.
- Converting iron and manganese to insoluble hydroxide sludge for easy removal.
- Reducing the formation of trihalomethanes.

A major drawback of using ozone is it converts bromides in the water to undesirable bromates. High cost and operational complexity of its production are also significant limitations to its use.

A comparison of ozone to other disinfectants is presented in Table 6.15.

6.4.6 Ultraviolet Light (UV)

UV radiation is a good biocide, but like ozone provides no residual for distribution protection. The drinking water industry's migration toward UV has been fueled by the finding that UV light can inactivate *Cryptosporidium parvum* at cost-effective dose. There are three type of UV systems currently used in drinking water. They are low-pressure (LP) lamps, LP high-output (LPHO) and medium-pressure (MP) lamps. LP and LPHO lamps emit irradiation primarily at 254 nm, while MP lamps deliver continuos-wave UV light at higher intensities and across a range of wavelengths. The table below gives some technical data for the three UV systems.

Table 6.16
COMPARISON OF THREE UV LAMPS

Parameters	LP	LPHO	MP
Spectral distribution	Monochromatic	Monochromatic	Polychromatic
Temperature-F/C	95-113/35-45	122-176/50-80	752-1652/400-900
Power, W	45-100	100-400	1,000-25,000
Track Record	Extensive	Limited	Low
# of lamps required	High	Moderate	Low

UV lamps are surrounded by quartz sheaths, and the jacketed lamps are immersed in the flowing water. The flow is typically in a closed pipe and may be parallel or perpendicular to the lamp axes. It is important to ensure turbulent flow conditions within the UV disinfectant unit to allow all elements of the fluid to come sufficiently close to the lamp surfaces while minimizing the degree of transverse mixing (short-circuiting). Careful monitoring of microbial inactivation and lamp intensity is a requirement with UV disinfection.

The contact times for UV disinfection systems can be relatively short, generally under 1 minute. Therefore, the space required for UV disinfection units is relatively small. Because no residual is created, an additional final disinfection process would be required. The potential for UV reactions to produce organic by-products is minor because the intensities required for UV disinfection are less than those needed to cause photochemical effects. Operationally, employing an effective cleaning program to periodically remove biological and chemical fouling materials from the lamp jacket or Teflon tube surfaces is essential.

A comparison of UV to other disinfectants is presented in Table 6.15.

6.5 RECOMMENDED DISINFECTION OPTION

The recommended disinfection alternative for the City's municipal treatment plant is to use sodium hypochlorite as a first disinfectant and chloramines as a second disinfectant. Sodium hypochlorite is an effective disinfectant that has few safety and health risks during transportation and handling, and is the least expensive disinfection alternative to chlorine gas due to the facts that sodium hypochlorite is more safe to handle and does not cause serious public health and safety related risks associated with accidental leakage of the chlorine gas. Like chlorine gas, sodium hypochlorite will combine with naturally occurring organic matter in the water to form DBPs. The amount and nature of organic material in the water to be treated during dam removal and how those organics react with chlorinated compounds is unknown. To protect against the possible presence of organics and subsequent potential for DPB formation, a chloramine process will also be constructed within the treatment facility. Chloramines are typically not used as a primary disinfectant. Chloramines are used to provide a chlorine residual in the finished water, but do not form organic DBPs to same extent as hypochlorites. By using chloramines in conjunction with sodium hypochlorite, the City will be able to meet all of the disinfection requirements while providing the operational flexibility to minimize DBP formation if substantial organic material is present in the incoming raw water.

The estimated cost for disinfection given in this report was based on the purchase of liquid sodium hypochlorite. The costs for using a chlorine gas system, having an on-site sodium hypochlorite generator and UV disinfection with an on-site sodium hypochlorite are provided in Table 6.17.

Table 6.17
DISINFECTION OPTION COSTS

Disinfection Options	Capital Cost	O&M Cost	Total 20-Year Present Worth[1]
Chlorine Gas System	$316,000	$14,000	$477,000
Sodium Hypochlorite (liquid @ 12.5%)	$221,000	$18,000	$427,000
Sodium Hypochlorite with On-Site Generator	$238,000	$14,000	$399,000
UV Plus Sodium Hypochlorite with On-Site Generator	$627,000	$12,000	$765,000

Notes:
[1]For 20 years at 6% interest rate. Present worth is based on annual compounding discount rate of 6% for a 20-year period.
[2]Costs are based on the first quarter of year 2001 prices.
[3]Costs do not include purchase of land, easements, and similar.

6.6 TREATMENT RESIDUAL DISPOSAL OPTIONS

6.6.1 Estimated Residual Quantities.

As discussed earlier, water for the municipal treatment plant will come from the existing Ranney collector. The current average turbidities of water within the Ranney collector range from 0.04 to 1.0 NTU. Other water quality data includes:

- pH 6.5 – 8.5
- TOC 20 mg/L
- TSS parameters 7 mg/L

TSS concentrations within the Ranney collector have not been recorded regularly. The only TSS measurement conducted in 1973 measured 0 mg/L TSS. Based on a long-term TSS value of 69 mg/L presented in Table 2.4 and a 90% removal rate from the Ranney collector, TSS in water from the Ranney is assumed to average 7 mg/L. For a conservative estimate of residuals production from a conventional treatment plant the annual average water quality (dosage) was assumed. In addition, it was assumed that 10 mg/L of coagulation chemicals would be required to settle the suspended solids. Residuals from a conventional treatment process are created both in the sedimentation basin and during filter backwash cycles. The estimated residuals production from a conventional treatment process (assumes 0.44 lb. dry sludge/lb. alum [*AWWA Water Quality and Treatment*, 5th Edition, 1999, page 16.3]) would be approximately 150 lb./day inorganic aluminum solids plus the TSS in the water (dry weight) at the average flow rate of 4 mgd, and 390 lb./dry (dry weight) at the peak flow rate of 10.6 mgd. This residual would be a combination of solids from the river and coagulation chemicals.

Unlike all the other conventional filtration processes, the residuals from membranes would consist of much more quantity of water. A typical percent recovery for membranes is approximately 85-90%, which means that 10-15% of the untreated water that passes through the membrane is rejected as waste. For example, assuming 200 mg/L of TSS in the untreated water and 90% membrane recovery, the estimated residuals from membranes is 1.1 MGD with 2,000 mg/L (0.2%) of TSS at the peak flow of 10.6 mgdl. The rejected waste could be further treated with additional membranes to achieve an overall maximum recovery of up to 98%, but at an additional capital cost. The rejected membrane waste would contain inorganic solids from the river but does not contain any coagulation chemical residual, since no chemicals are typically used in the treatment process.

Additional residuals from a membrane process are also created during membrane backwash cycles, where solutions of acid and or base are used to clean the membrane units. It is difficult to determine the amount of backwash water that would be created without pilot testing of the anticipated water quality. The residual water created during these backwash events may be acidic or basic. Many times this residual water is treated to a neutral pH before being handled in the same manner as daily reject water.

6.6.2 Settling Pond/Landfill Disposal

A common practice for the handling of residuals from municipal treatment plants utilizes multiple holding basins that allow time for the solids in suspension to settle on the bottom. The water in these basins is decanted off the top and run back through the treatment plant. The solids at the bottom of the basins would need to be removed periodically. Solids are removed by first taking the active basin off-line and diverting residuals handling to one of the other basins. Next the water is decanted off the top of the basin exposing the residuals to be removed.

The solids at the bottom of the settling ponds generally will contain about 5% solids and presents some difficulties for transport and disposal. One option would be to try and dispose of the residuals while wet. The residuals would be transported as liquid to a landfill facility that can accept liquid wastes under PL-91-512 (Solid Waste Disposal Act). At the average treatment plant flow rate approximately 650 cubic yards of residuals at 5% solids would be collected each year. This represents an expensive option in regards to transportation and disposal costs, since there are no landfills that accept liquid waste in the immediate vicinity of Port Angeles.

A preferable option would be to dewater the residuals before disposal. Residuals can be thickened naturally by allowing in-place air drying or removal and placement on drying beds, depending on the climatic conditions. In Port Angeles the average precipitation of 26 in/yr exceeds the average lake evaporation of 22 in/yr. Typically a six month period of excess evaporation is needed to achieve adequate drying, therefore natural drying is probably not well suited for this climatic area. Another option would be to remove the residuals and mechanically dewater with rented filter press or belt press equipment. For ordinary landfill disposal the sludge would have to be chemically stabilized with use of polymers and mechanically dewatered to reach a 25% solids concentration to qualify as a “solid” for disposal purposes.

Based on the anticipated residual quantities presented above, approximately 130 cubic yards of dewatered residuals would be created each year. The frequency that this waste would need disposal would depend on the size of the settling basin and the on-site storage capacity. It is estimated that a basin 200 feet square with 3 to 1 side slopes and 5 feet deep would need to be cleaned once every 9 years.

According to the City of Port Angeles, the municipal solid waste landfill located within the city limits, is scheduled for closure by 2007. The City plans to truck all municipal waste to an out-of-town landfill after the closure that would represent an additional transportation cost to this option.

Using a settling basin and disposing of solids in a landfill is more difficult for municipal residuals created through membrane treatment. The solids in a membrane reject water are not likely to settle within the basin because they consist of mostly stable inorganic colloids. A coagulant could be added to the basins to destabilize the colloids and promote settling, but the operation and optimization of settling within the retention ponds would be operator intensive and add additional chemical costs to the treatment process.

6.6.3 Settling Pond/Reuse with Composted Wastewater Biosolids

Similar to the previous option the water treatment residuals would be placed into multiple holding basins and ultimately removed and dried to be combined with the composted wastewater biosolids from the City’s wastewater treatment plant. The composting operation is located at the City landfill site. The combined water and wastewater residuals may be reused for agricultural purposes, soil amendment, fill, cover, and similar uses.

6.6.4 Ocean Discharge

Another residuals option that would not require dewatering, transportation and disposal would be to pump treatment residuals directly to the ocean. This option would require higher capital costs for the pipeline, ocean outfall, and pumping station than settling and landfilling. In addition, the continued pumping cost and environmental monitoring cost of residuals disposed in the ocean would be greater than the periodic cost of dewatering, transporting and disposal.

This option would be suitable for municipal water treatment residuals generated from either conventional treatment or membranes. In addition, this option would be highly suitable for disposal of residuals created during the treatment of the industrial and fisheries demand, because of the substantial volumes generated.

Discharge to the ocean would require a NPDES permit from the state under WAC 173-220. The permit would be acquired from the State of Washington and would require a public comment period and addition review by other government agencies such as, the Army Corps of Engineers, the United States Fish and Wildlife Service, the National Marine Fisheries Service, other state agencies and the Lower Elwha Klallam Tribe.

The Daishowa mill currently has an NPDES permit to dispose of treatment residuals with a shoreline outfall located directly at the edge of the treatment plant boundary. There is no pumping cost, or pipeline maintenance associated with their disposal.

6.6.5 Sanitary Sewer Disposal

An additional disposal option for municipal residuals would be discharge to the sanitary sewer system and treatment by the City wastewater plant. Municipal residuals from conventional or membrane treatment could be directly discharged to the sewer or be put through a gravity thickening process to decrease volumes discharged. Direct discharge to the sewer would produce about 88,000 gpd of 1% TSS residuals at an average treatment capacity (4.4 mgd) or 212,000 gpd of 1% TSS residuals under peak capacity (10.6 mgd). Additional hydraulic capacity in the sewer and wastewater treatment plant would be required to accommodate the additional flow. The residuals would appear as inorganic solids within the biosolids of the primary clarifier.

6.6.6 Discharge to Surface Water

The disposal of residuals from the conventional treatment of the municipal water supply to a nearby stream or river would not be a viable option because of the permitting challenges associated with discharging a chemical residual into a receiving water. Even disposal back into the Elwha River during dam removal is not viable because municipal residuals disposal will be a long-time operation and maintenance requirement required after the water quality in the Elwha River has been restored requiring the construction of residuals handling facilities.

Municipal residuals created from membrane treatment may potentially be permitted for disposal in the river because of the absence of chemical residue. The pH of membrane backwash water may need to be adjusted prior to disposal.

6.6.7 On-Site Residuals Dewatering

Another disposal option for municipal residuals would be discharge to the concrete equalization tank with the hydraulic detention of one day, then pump the sludge to the concrete gravity thickener with the hydraulic detention time of 2 days. After settling for 2 days, the sludge is sent to a belt press. The solids content form the equalization tank is between 0.5 and 1%, and the solids content after the gravity thickener is about 4%. The solids content after the belt press is around 25-30%, which meets the requirement of landfill disposal or if combined with composed wastewater biosolids for agricultural, fill, cover, or similar uses.

6.7 RECOMMENDED TREATMENT RESIDUAL DISPOSAL

The recommended alternative for disposal of treatment residuals will be to use settling ponds. Two settling basins will be required. Solids from the treatment plant clarifier and filter backwash water will be pumped to a lined detention pond that will allow the solids to settle. Decant water from the top of the ponds will be pumped back through the treatment plant. The settled solids will be periodically removed by changing operations to the other basin, draining off the remaining decant water, chemically stabilizing the solids, and mechanically dewatering the solids with rented equipment prior to disposal or reuse. As previously described, it is estimated that the ponds would require solids removal once every 5-10 years depending on the solids generated. Until 2007 the solid may be disposed of in the City's landfill. The City is currently exploring how to dispose the solid wastes after 2007, and hence the associated costs for the treatment residual disposal will change after the year 2007. As an estimate of the cost change, residual disposal cost will be increased by 30% after 2007. As a result of the landfill closure the combination of the water treatment residuals with biosolids compost is the most favorable option.

Though the settling ponds are recommended, the cost for the use of gravity thickening with a belt press was compared with the recommended option of residual disposal (see Appendix G), which is presented in Table 6.18.

Table 6.18
COST COMPARISON BETWEEN RECOMMENDED AND ON-SITE RESIDUAL DEWATERING OPTIONS

Treatment Residual Disposal	Subtotal	Construction (40%)	Engineering (20%)	Total Cost
Recommended Option	$1,148,000	$459,000	$321,000	$1,928,000
On-Site Residual Dewatering Option	$1,634,000	$654,000	$457,000	$2,745,000

Note:
[1] The gravity thickener with belt press option includes treatment residual equalization tank, gravity thickener, belt press, dewatered sludge holding tank, polymers, and associated pumping and piping systems.

As described in the next section, many of the proposed locations for the water treatment plant are near the Fairchild International Airport. The Federal Aviation Administration (FAA) has restrictions on open bodies of water near airports in order to reduce the potential for attracting birds. The regulations state that open bodies of water are prohibited within a 10,000-foot radius of the airport boundary. These regulations are open for interpretation by individual airports. For the Fairchild International Airport, the ocean is well within this 10,000 foot restricted area. Based on the location of the recommended treatment plant site, and discussions with airport staff, the treatment residuals settling ponds may require measures to deter birds from interfering with airport operations. Use of netting over the settling ponds similar to the netting used at the WDFW rearing channel is recommended.

6.8 POSSIBLE TREATMENT PLANT LOCATIONS

6.8.1 General Location Criteria

Criteria used in siting a treatment plant site include available land. The proposed treatment plant will require approximately 10 acres. The plant will typically have single story buildings and possibly some high bay buildings. Truck access is required for chemical delivery and general operation and maintenance. The site will have net protected (similar to WDWF rearing channel net coverage) water ponds for sludge handling as it is assumed that the open water will attract birds. Possible plant locations reviewed to date include properties owned by the City of Port Angeles, the Port of Port Angeles, Rayonier, and private individuals. Possible treatment plant locations are shown on Figure 6.7.

Site evaluation criteria used for siting a treatment plant include hydraulics, site factors, plant pipelines, and location of other utilities. These criteria are identified as follows.

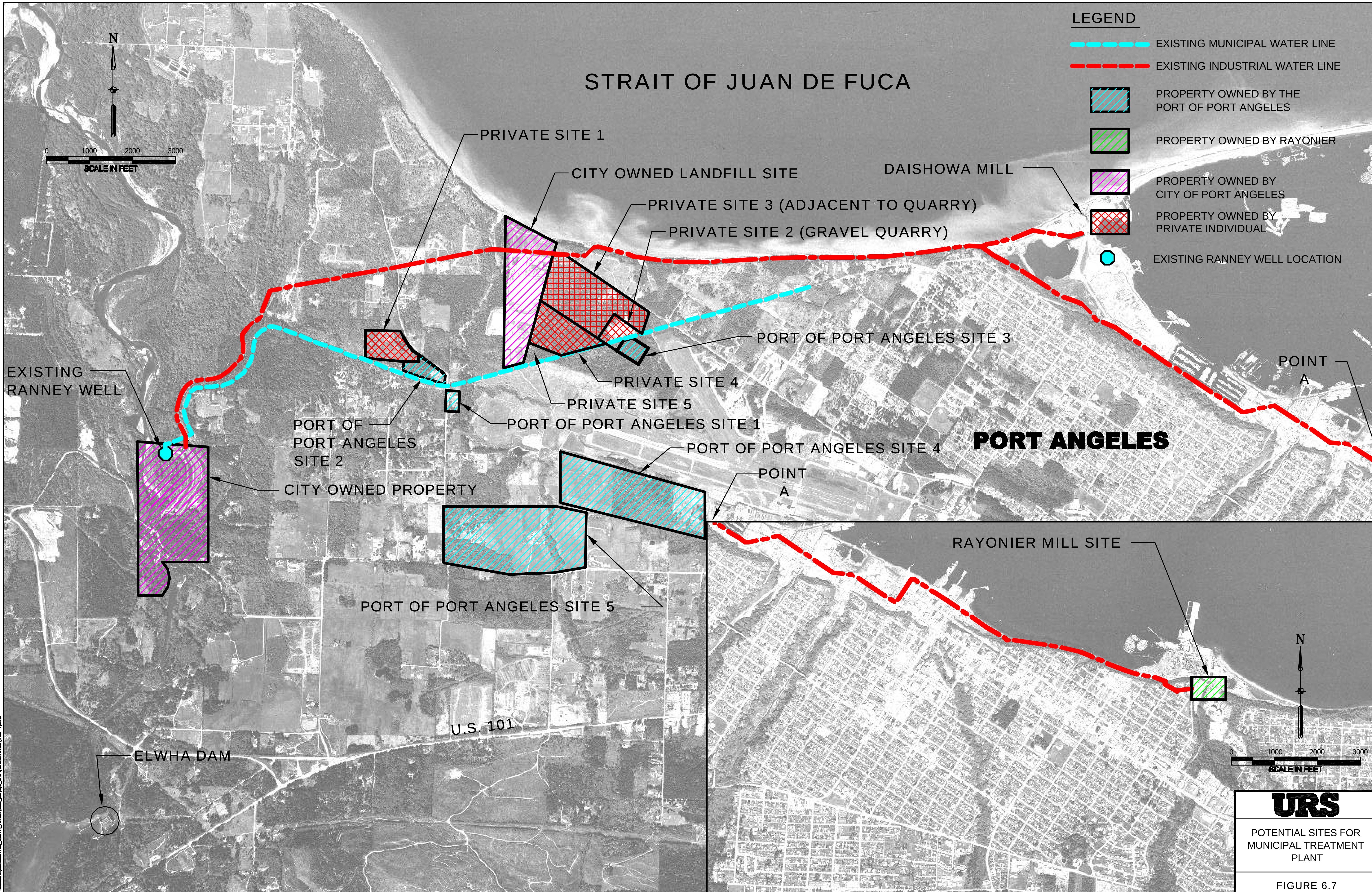
6.8.1.1 Hydraulics

The existing system uses the pumps in the Ranney well to provide high pressure discharge pumps. Treatment plant locations will have to break pressure, treat the water and re-pressurize to get the treated water from the plant back into the system. Plant location should be sited to minimize additional water line construction to get water into different pressure zones.

6.8.1.2 Site Factors

Site location will need to consider the following items:

- Topography
- Initial plant construction with available room for expansion
- Operation and maintenance requirements
- Geology
- Environmental considerations, wetlands
- Compatibility of the proposed buildings with the adjacent land uses.
- Security
- Access
- Proximity of the plant with respect to the availability of existing water distribution facilities, electrical power, gas and communication utilities



POTENTIAL SITES FOR MUNICIPAL TREATMENT PLANT

FIGURE 6.7

- Zoning

6.8.1.3 Plant Pipelines

Plant siting needs to be close to the location of the existing pipeline from the Ranney well to distribution. The further the plant is away from the existing pipeline, additional expense will be needed to pipe water from the existing pipeline to the plant and back to the distribution system. It is also advantageous to have the sludge storage and evaporation ponds close to the plant to reduce the piping between sedimentation and filtration to the ponds.

6.8.1.4 Other Utilities

Treatment plants will require other utilities for operation including sanitary sewer, storm sewer, electric, gas, communication and telemetry. Having a treatment plant in a remote location will increase the overall capital cost of the facility because of the utility extensions required to provide service.

6.8.2 Plant Locations - Properties Owned by the City of Port Angeles

Properties currently owned by the City of Port Angeles identified for possible treatment plant locations include the following:

- City owned property along the Elwha River at the existing Ranney well and WDFW rearing channel
- South end of City landfill

The site of the current Ranney collector and WDFW fish rearing facility is not of sufficient size to support the approximate 10 acres required for construction of a municipal treatment plant. The site is bordered by the Elwha River on one side and a steep hill on the other. The WDFW fish rearing channel runs the entire length of the property. There is insufficient room for a filter facility or treatment residuals settling pond.

The City also owns a 40-acre parcel of land south of the WDFW facility. The majority of this parcel is on a steep hill and heavily wooded. The industrial intake and tunnel are located on this parcel. The amount of flat land available to construct a plant is very limited on this parcel and therefore not considered a feasible site.

Further south of the industrial intake, the City owns a small parcel on the west side of the river. This parcel is too small for a municipal treatment plant and would require intake and distribution piping to be constructed under the river.

The City landfill site is a possible location for the water treatment plant as shown on Figure 6.7. The current landfill is scheduled to be closed by 2007. The southern portion of the landfill site is located near the municipal distribution pipeline and consists of natural undisturbed soil. It is currently being used for material storage and as a transfer station. The wastewater treatment biosolids composting facility is located on the site and hence offers a potential water treatment residuals management option. Issues with this site include topography, environmental conditions and existing building structures. In addition to the composting operation being located at the landfill site, another advantage of this site is that the City is the current owner of the site and is planning redevelopment of the site to accommodate other City facilities compatible with water treatment facilities.

6.8.3 Plant Locations - Properties Owned by the Port of Port Angeles

Figure 6.7 shows the location of four possible treatment plant sites currently owned by the Port of Port Angeles. The sites are all in close proximity to the Fairchild International Airport. The Port of Port Angeles Site 1 is located on the east side of Lower Elwha Road, just south of the City's water line which comes directly from the Ranney collector. The site is relatively flat and clear of heavy vegetation. A drainage runs along the east side of this site and shows some evidence of erosion of the site and possible flooding. The site is in close proximity to the municipal distribution pipeline, has good vehicle access, and has utility access. Based on communication with the Port of Port Angeles and the Fairchild Airport Manager, this site has restrictions placed on it by the Federal Aviation Administration (FAA). The site was purchased with FAA funding and therefore cannot be sold. The Port of Port Angeles has indicated that it may be possible to develop a long-term lease on the property.

The Port of Port Angeles Site 2 is also on Lower Elwha Road, located on the west side and north of the existing water line coming from the Ranney collector. This site also has good access to existing utilities and does not have the same FAA site restrictions that the Site 1 has. The Site 2 is also in close proximity to the existing water line.

The Port of Port Angeles Site 3 is located on the west side of the north-south runway. This site has the same FAA restrictions as Site 1 and could not be purchased outright for the construction of a water treatment plant.

The Port of Port Angeles Site 4 is immediately adjacent to the Fairchild International Airport east-west runway. This site is being considered by the Port as a prime site for future development as an airport industrial park. The site is also not located near the existing water system transmission main and would thus require a costly pipeline extension to deliver untreated water to the site and a parallel treated water return pipeline. As a result of these two factors, this site will not be considered further.

Discussions with the Port of Port Angeles have suggested looking at another site which contains about 140 acres. This site is shown as Port of Port Angeles Site 5 on Figure 6.7. The site does not have any of the FAA restrictions on sales of the property. The disadvantage with the site is that it is not adjacent to the existing water line. Inlet and treated water pipeline to and from the plant will be required to connect to the existing pipeline. The length of pipeline required would be approximately 10,000 feet. Much of this site is heavily wooded with apparently poor surface water drainage. The eastern portion of the identified property is flat, unvegetated and does not appear to have drainage concerns. A visual inspection of this parcel revealed it is currently being used for agriculture. Just north of this property is a parcel used for flying remote controlled airplanes that would be another strong potential for a municipal treatment plant site.

All of the sites identified above are within a 10,000 foot radius of the airport boundaries, and therefore have restrictions prohibiting the construction of an uncovered settling pond for treatment residual disposal.

6.8.4 Plant Locations - Property Owned by Rayonier

Another proposed location for a municipal treatment plant is the site of the former Rayonier mill, which is located near the City of Port Angeles wastewater treatment plant. Hydraulically, the existing water distribution system for the City is set up to receive water from the west side of the City. The existing infrastructure has the larger diameter pipes at the west end. Locating the water treatment plant at the Rayonier site would involve upgrading the existing water distribution system to incorporate larger diameter pipes from the Rayonier site. The existing, but currently non-operational, Jones and Water Street Pump Station would have to be upgraded to transport all of the treated water into the City of Port Angeles distribution system. In addition, the 9th & Jones Street Pump Station would have to be upgraded.

The Rayonier site is currently under investigation by the EPA, Washington State Department of Ecology and the Lower Elwha Klallam Tribe for environmental contamination caused by mill activities. The remedial investigation work plan is scheduled to be complete by January 2002.

In addition, the Rayonier site is also currently under investigation for potential commercial development by both the City and the Tribe. The Lower Elwha Klallam Tribe has also identified portions of the site that have cultural and historical significance. For all these reasons, the former Rayonier site is not considered a viable option for a municipal water treatment plant site.

6.8.5 Plant Locations – Property Owned by Private Individual

There is the possibility of purchasing private property for the treatment plant site. The first consideration would be to determine if the property has the correct zoning for use as a treatment plant. The disadvantage includes the costs for acquiring the property and need to remove any residential structures on the site.

Figure 6.7 shows the locations of four possible treatment plant sites currently owned by private parties. The property location, area, and ownership are listed below:

Table 6.19
POTENTIAL PRIVATE PROPERTY FOR WATER PLANT LOCATIONS

Property ID	Location	Area, Acre	Owner
Private Location Site 1	West of Port of Port Angeles Site 2	16.52	Jaretta H. Pollow J.H. Dobrowsky
Private Location Site 2	Gravel Site West of Port of Port Angeles Site 3	4.57	Reggie L. Nason
Private Location Site 3	North of Gravel Site	63.29	Unknown
Private Location Site 4	Northwest of Gravel Site	31.15	Reggie L. Nason
Private Location Site 7	East of City landfill and south of private site 4	1.56	Unknown

All of the privately owned sites would require removal of existing trees, stumps and/or surface vegetation. Extensive removal of trees from Private Sites 3, 4, and 5 would be required. Site 2 is a quarry and would require extensive regrading or the use of imported material to restore the site. Private site 5 is not large enough for the entire treatment facilities but may be desirable if a portion of Private Site 4 were obtained for the plant location. All of the private sites would require the land to be purchased.

6.9 RECOMMENDED TREATMENT PLANT LOCATIONS

Based on the findings of a plant site review meeting on June 27, 2001 with ONP, Reclamation, the City, and the Tribe the top five sites were prioritized. The sites were selected and are listed from being most desirable to less desirable as follows.

1. City owned landfill site
2. Private Site 4 and 5
3. Port of Port Angeles Site 3
4. Port of Port Angeles Site 2
5. Port of Port Angeles Site 1
6. Port of Port Angeles Site 5

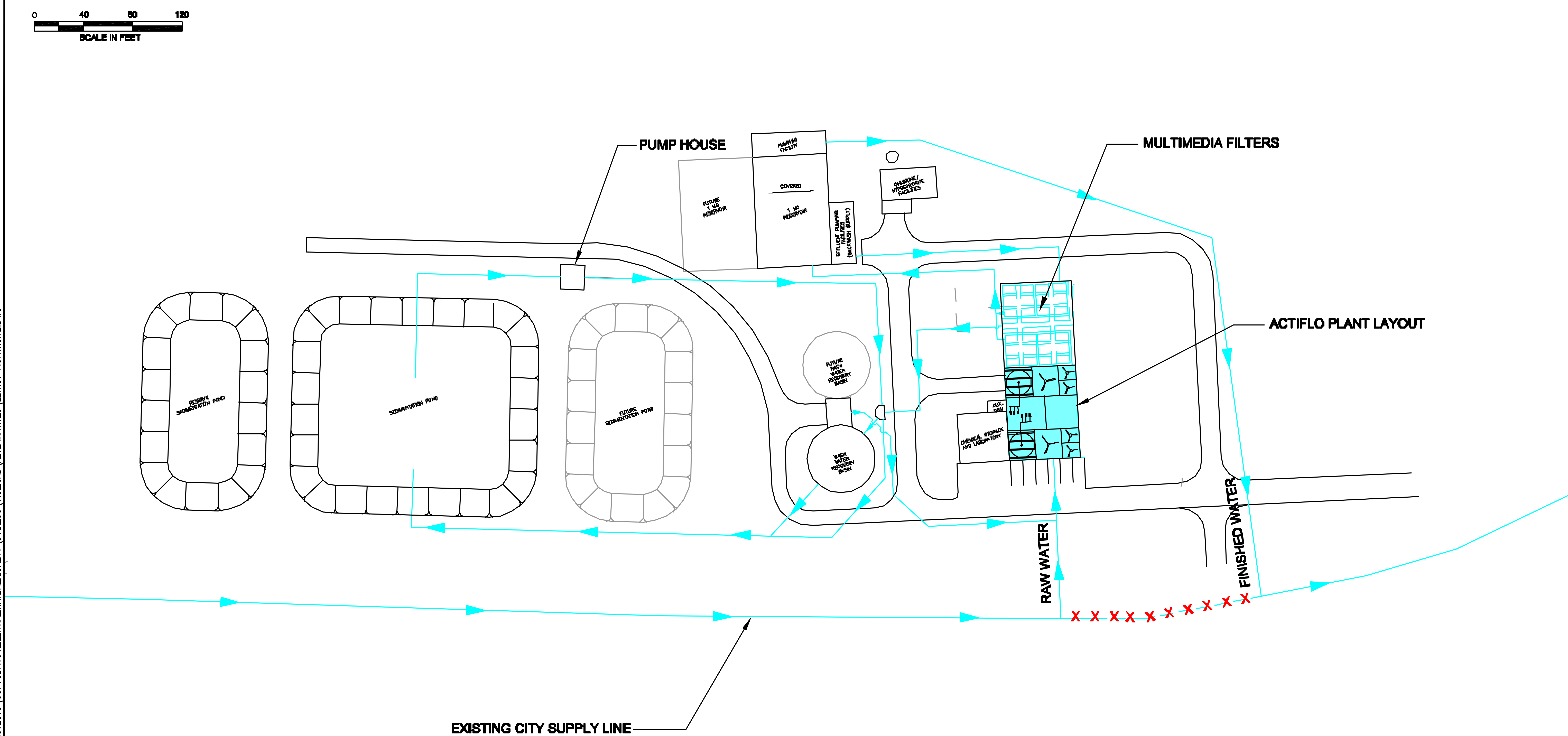
There are three recommended treatment plant locations at this time based on a cursory review of all the identified sites. The City owned landfill site, Private Site 4 and 5, and the Port of Port Angeles Site 3 are potential candidates for the development of a treatment plant. The Port of Port Angeles Site 3 is relatively flat recently logged and undeveloped and could be available for construction immediately. Private Sites 4 and 5 are immediately adjacent to the City owned landfill site and could be used as an extension for the development at the landfill site. Only 10 acres of the 32 plus acres of the site are proposed for water treatment usage. Use of the landfill site will require coordination with other proposed uses of the site that are currently being planned and include the composting facility, material storage, and transfer station. The advantage with this site is that the City is the current owner of the site, and the wastewater biosolids composting facility is onsite and would provide easy access for handling of water treatment residuals. The two private sites or the Port of Port Angeles Site 3 would have to be purchased or leased.

Table 6.20 is summary of the site evaluation criteria for each of the four sites considered.

For the purposes of this report, it is recommended that the City landfill site will be the treatment plant location. A siting study to further examine the environmental issues, geological and geotechnical issues, and property acquirement and cost issues will be required. Additionally an agreement with the City will be required for use of the land before the recommendation can be confirmed.

The site layout for an Actiflo plant, filter units, and treatment residuals disposal on the landfill site is shown on Figure 6.8. The entire treatment plant will be enclosed and include office space, laboratory space, and chemical storage.

At the time of this report, there are four residences currently upgradient of the proposed treatment plant between the existing Ranney collector and the proposed treatment plant sites. Based on discussions with the City of Port Angeles' utility engineer, these residences may be transferred over to the Dry Creek Water Association (if accepted by DCWA) as a result of the recent GWI classification of the current source and lack of sufficient chlorine contact time in the present system.



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LAYOUT FOR RECOMMENDED MUNICIPAL WATER TREATMENT PLANT

FIGURE 6.8

Table 6.20
MUNICIPAL WATER TREATMENT PLANT SITE EVALUATION CRITERIA

Potential Site	Compatible with Adjacent Land Use	Affect by Airport Restrictions	Access to Existing Delivery and Distribution System	Electric Power Availability	Residuals Disposal	Ownership
City Landfill	Other City facilities are on the same site	Yes	Close to existing systems	Yes	Closest to wastewater biosolids composting and reuse	City
Private Site 4 and 5	Adjacent to proposed City facilities on landfill site Currently undeveloped	Yes	Close to existing systems	Yes	Within 0.2 miles of the wastewater biosolids composting and reuse operation	Private
Port of Port Angeles Site 3	Currently undeveloped Surrounded by undeveloped property	Yes and is the closest to the airport	Close to existing systems	Yes	Within 0.6 miles of the wastewater biosolids composting and reuse operation	Port of Port Angeles Possible long term lease required